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RAPID COMMUNICATION / COMMUNICATION RAPIDE

## Genetic diversity of butternut (*Juglans cinerea*) and implications for conservation

Amy Ross-Davis, Michael Ostry, and Keith E. Woeste

**Abstract:** The management of threatened and endangered species can be improved by understanding their patterns of genetic diversity and structure. This paper presents the results of the first analysis of the population genetics of butternut (*Juglans cinerea* L.) using nuclear microsatellites. Butternut once was an economically and ecologically valuable hardwood, but now its numbers are rapidly decreasing throughout its native range in eastern North America. By genotyping butternut trees ( $n = 157$ ) from five populations at seven highly polymorphic loci, we determined that the remaining genetic diversity for the species is considerably higher than previously estimated (mean  $H_E = 0.75$ ). Populations were nearly genetically homogenous ( $F_{ST} = 0.025$ ), with no evidence of isolation by distance. These results indicate that butternut retains a large amount of genetic diversity, and that it is not too late to implement strategies to conserve local butternut populations.

**Résumé :** La gestion des espèces menacées et en voie de disparition peut être effectuée de façon plus judicieuse par la compréhension des patrons de diversité génétique et de sa structure. Les auteurs ont analysé pour la première fois la génétique des populations du noyer cendré (*Juglans cinerea* L.) au moyen de loci nucléaires de microsatellites. Le noyer cendré était jadis une espèce feuillue précieuse du point de vue économique et écologique avant de voir ses effectifs diminuer rapidement partout dans son aire de distribution naturelle dans l'est de l'Amérique du Nord. Les auteurs ont déterminé les génotypes des noyers cendrés ( $n = 157$ ) de cinq populations pour sept loci hautement polymorphes. La diversité génétique résiduelle de l'espèce est apparue considérablement plus élevée que les estimations antérieures ( $H_E$  moyenne = 0,75). Les populations étaient quasi homogènes génétiquement ( $F_{ST} = 0,025$ ), ne présentant aucun indice d'isolement par la distance. Ces résultats indiquent que le noyer cendré a conservé une diversité génétique élevée et qu'il n'est pas trop tard pour mettre en application des stratégies visant à conserver des populations locales de cette espèce.

[Traduit par la Rédaction]

### Introduction

Butternut (*Juglans cinerea* L.) is a short-lived tree species being extirpated throughout most of its native range (Fig. 1) by an epiphytic of butternut canker disease (Nielsen et al. 2003; Schultz 2003). Dramatic declines in butternut populations over the past few decades have resulted in the listing of butternut as endangered in Canada (Nielsen et al. 2003) and as a regional forester sensitive species in the USA. The disease was reported first in Wisconsin in 1967 (Renlund 1971), but it is believed to have spread from the southeastern USA (Nesom 2005). The causal agent of butternut canker, the fungus *Sirococcus clavigignenti-juglandacearum* Nair, Kostichka & Kuntz, was not described as a new spe-

cies until 1979 (Nair et al. 1979). The origin of the fungus is unknown; the genetic uniformity of the pathogen, however, probably indicates that it is a recently-introduced exotic species (Renlund 1971; Ostry 1997; Furnier et al. 1999). The fungus causes branch and stem cankers that ultimately girdle and kill host trees. Although butternut is susceptible to damage from other diseases and pests (Rink 1990), butternut canker is the greatest threat to the species' existence. By the 1990s, 91% of the butternut trees in Wisconsin were diseased (Schultz 2003), with similar infection trends reported across the species' range (Nielsen et al. 2003; Ostry and Woeste 2004; Schultz 2003) and the greatest losses occurring in the southern USA (Thompson et al. 2006). In Canada, butternut canker was first detected and confirmed in Ontario and Quebec in 1991 (Davis et al. 1992) and in New Brunswick in 1997, where it was thought to have been present for at least 7 years (Harrison et al. 1998).

Butternut grows best on well-drained rich (often riparian) soils. It is typically found in highly dispersed populations of a few widely scattered individuals in mixed-hardwood forests. Butternut was also historically planted on farmsteads throughout its range to provide a convenient source of nuts (Nesom 2005). Butternut's soft, tan heartwood is used for cabinet work, furniture, instrument cases, paneling, and turnery, and its sweet oily nuts are valued by humans for their

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